

LOW MASS VECTOR MESON MEASUREMENTS VIA DI-ELECTRONS AT RHIC BY THE PHENIX EXPERIMENT

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For the PHENIX collaboration.

10th November, 2008



1 MOTIVATION

2 THE PHENIX DETECTOR

3 RESULTS

- ϕ, ω in $p + p$ and $d + Au$
- Nuclear modification factors in $d + Au$
- Spectras

4 SUMMARY

Low mass vector mesons (ρ, ω, ϕ) are important to understand several aspects of HIC.

- Systematic measurements of different particles is needed to understand the medium properties:
 - by comparisons of p_T/m_T spectra of ϕ and ω in several decay modes.
 - Nuclear modification factors, R_{AA} .
comparison of several mesons allows to disentangle if suppression is mass or quark number or flavor dependent.
- as probes to chiral symmetry restoration. This can be manifested as:
 - a modification of line shape parameters (mass or width) inside the nuclear medium.
 - a difference in the yields between the hadronic and leptonic decay channels. e.g. branching ratio of the ϕ decay through e^+e^- and K^+K^- may be sensitive to mass modification. Since ($m_\phi \sim 2M_K$) \Rightarrow , small changes in ϕ or K can induce significant change in yields of the two decay modes.

Topics covered in this talk

- Spectra measurement of $\phi \rightarrow e^+e^-/K^+K^-$; $\omega \rightarrow e^+e^-/\pi^+\pi^-\pi^0/\pi^0\gamma$.
- Comparison between different decay modes.
- Nuclear modification factors.

The results covered in this talk correspond to data $\sqrt{s_{NN}} = 200$ GeV.

1 MOTIVATION

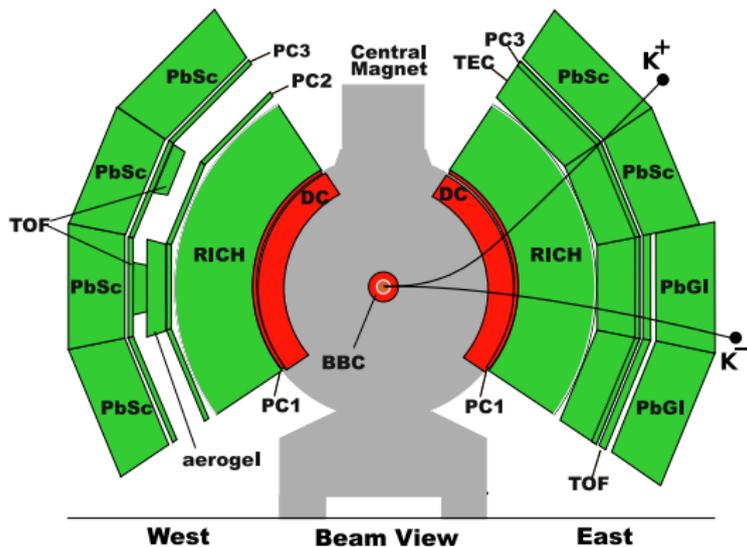
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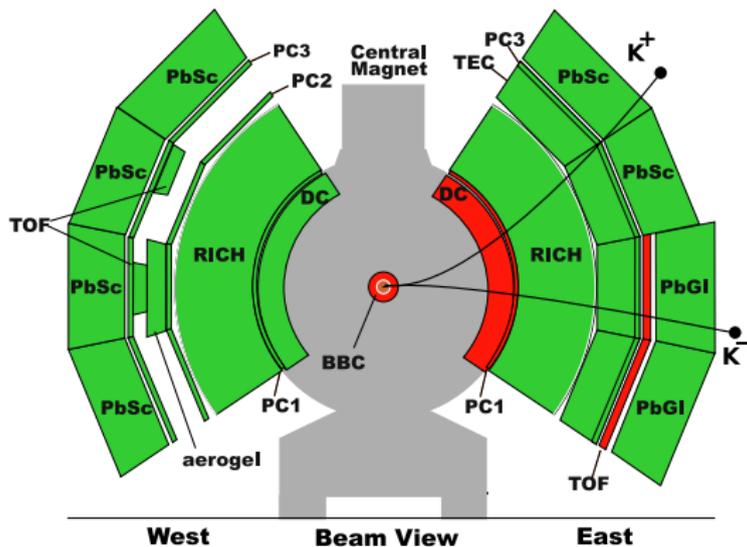
PHENIX Central arms Acceptance: $-0.35 < \eta < 0.35, 2 \times 90^\circ$ in φ



- Vertex: **BBC**
- Tracking: **DC/PC1**
- Trigger:
 - **Min. bias: BBC**
 - **e: RICH, EmCal**
- **h ID: Time-of-flight**
 - **TOF** $d\tau \sim 100$ ns
 - **EmCal** $d\tau \sim 500$ ns
 - **Aerogel** $d\tau \sim 500$ ns
- **e ID:**
 - **RICH** (e/π rejection > 1000)
 - E-p matching **EmCal** (e/π rejection ~ 10)

- $\phi \rightarrow K^+ K^-$ (No Kaon ID): All charged tracks are assumed to be Kaons.

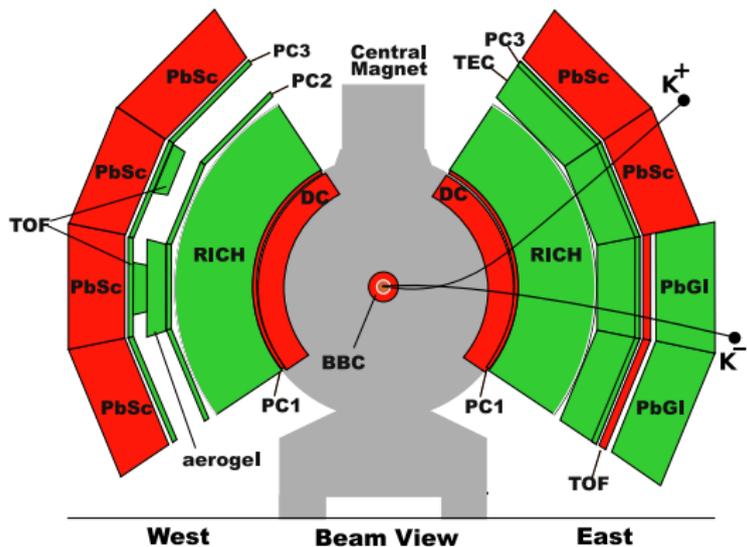
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- $\phi \rightarrow K^+ K^-$ (One Kaon ID): One of the two tracks is identified as Kaon using the TOF.

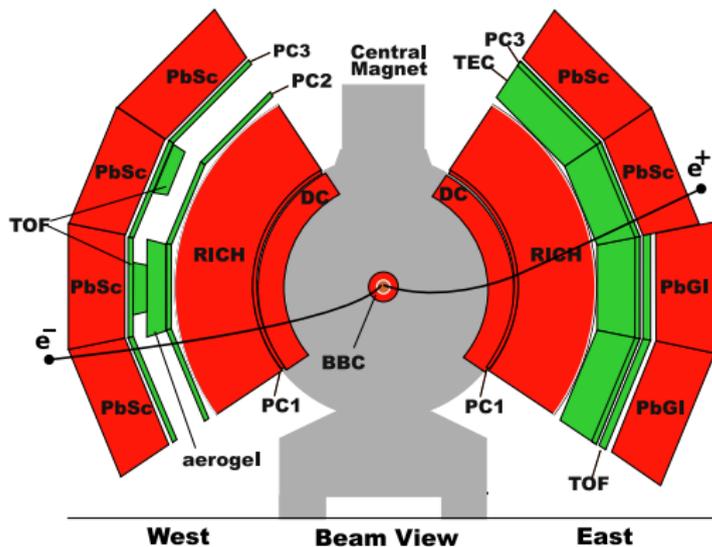
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- $\phi \rightarrow K^+ K^-$ (Both Kaon ID): Both tracks are identified as Kaons in the TOF or EmCal (For details, see poster by Yuri Ryabov)

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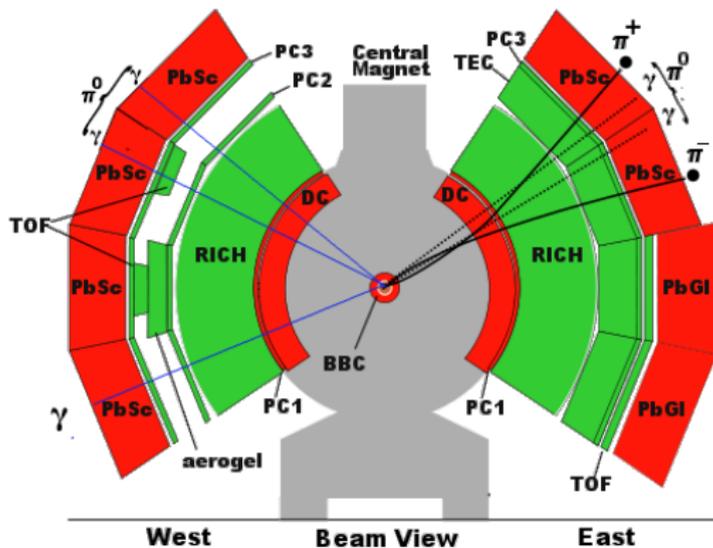


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● $\phi/\omega \rightarrow e^+e^-$

THE PHENIX DETECTOR

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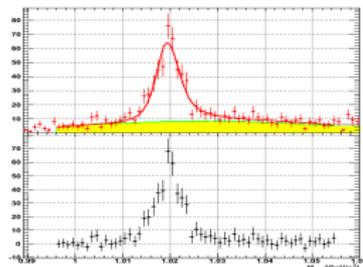


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● $\omega \rightarrow \pi^+ \pi^- \pi^0, \pi^0 \gamma$

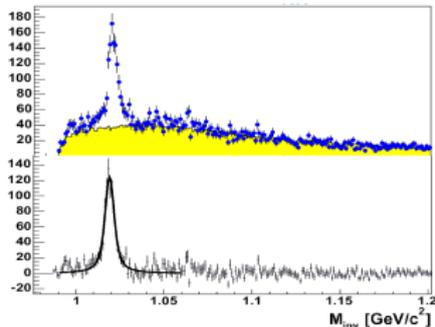
ϕ - MASS SPECTRA EXAMPLES

$p + p$

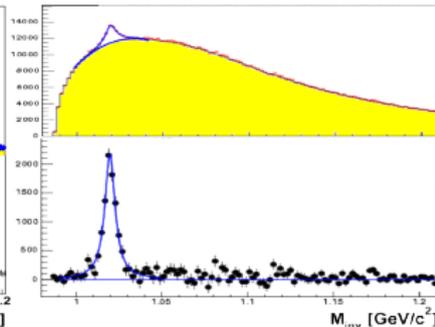


$\phi \rightarrow K^+ K^-$

$d + Au$

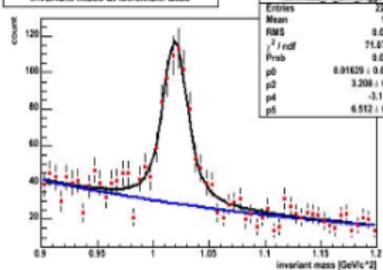


$Au + Au$

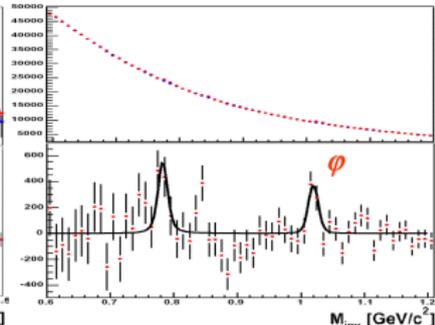
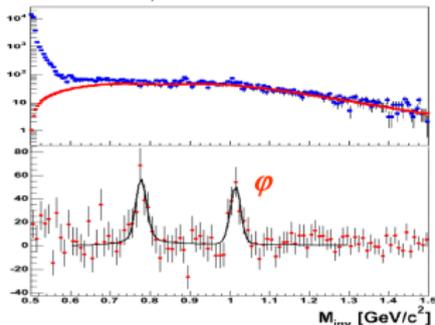


$\phi \rightarrow e^+ e^-$

Invariant mass at Minimum Bias

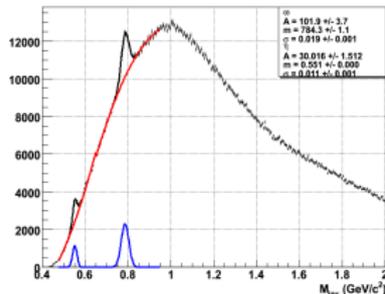


Histogram of ERT trigger	
Entries	22381
Mean	1.026
RMS	0.07468
χ^2 / ndf	71.07 / 56
Prob	0.08455
p0	0.01629 ± 0.00291
p1	3.306 ± 0.245
p2	-3.1 ± 0.3
p3	0.512 ± 0.388

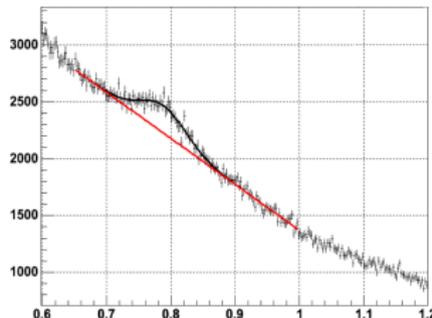


ω - MASS SPECTRA EXAMPLES

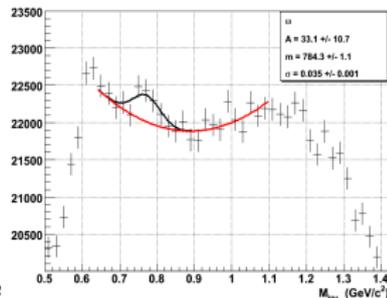
$p + p$
 $\omega \rightarrow \pi^+ \pi^- \pi^0$



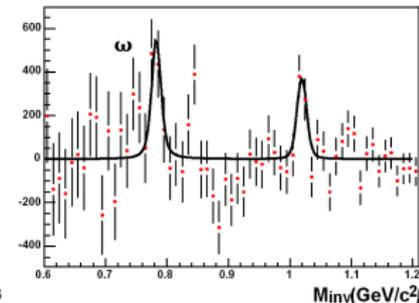
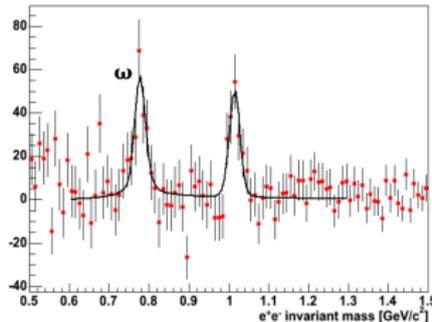
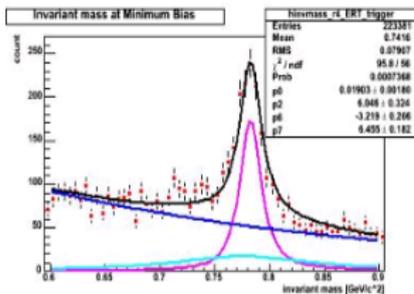
$d + Au$
 $\omega \rightarrow \pi^+ \pi^- \pi^0$



$Au + Au$
 $\omega \rightarrow \gamma \pi^0$



$\phi \rightarrow e^+ e^-$



1 MOTIVATION

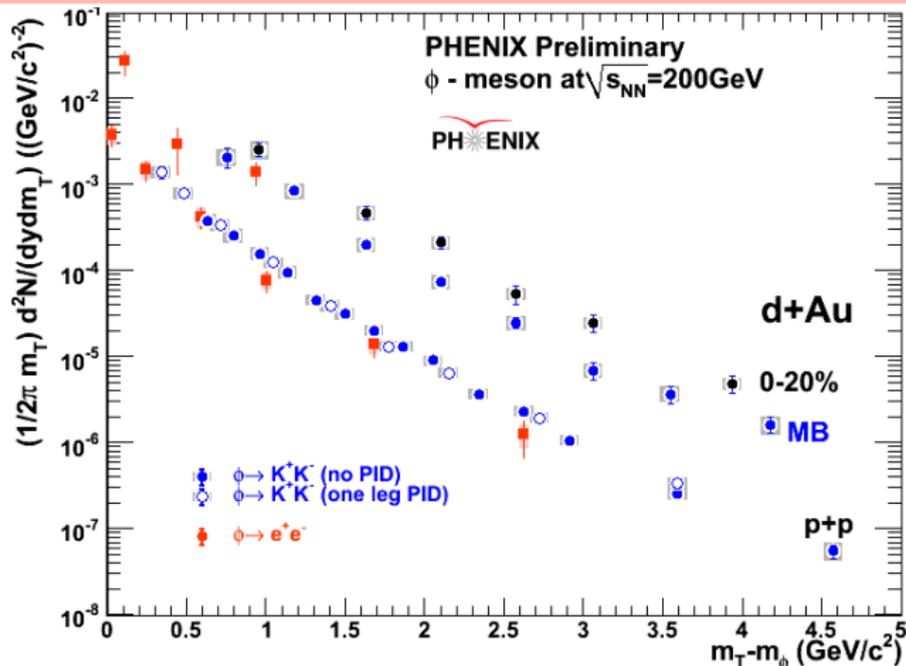
2 THE PHENIX DETECTOR

3 RESULTS

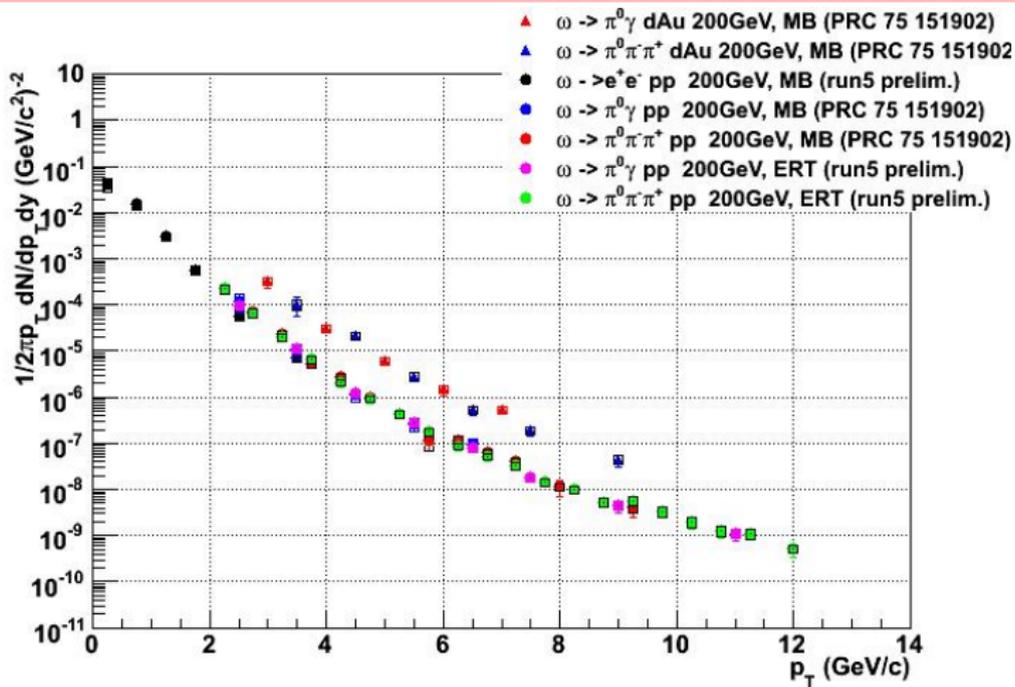
- ϕ, ω in $p + p$ and $d + Au$
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4 SUMMARY

ϕ - SPECTRA IN $p + p$ AND $d + Au$

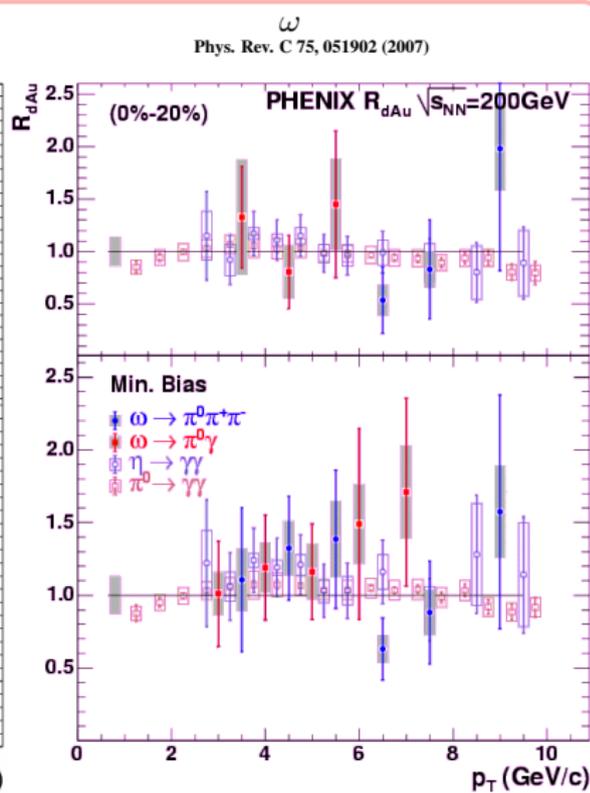
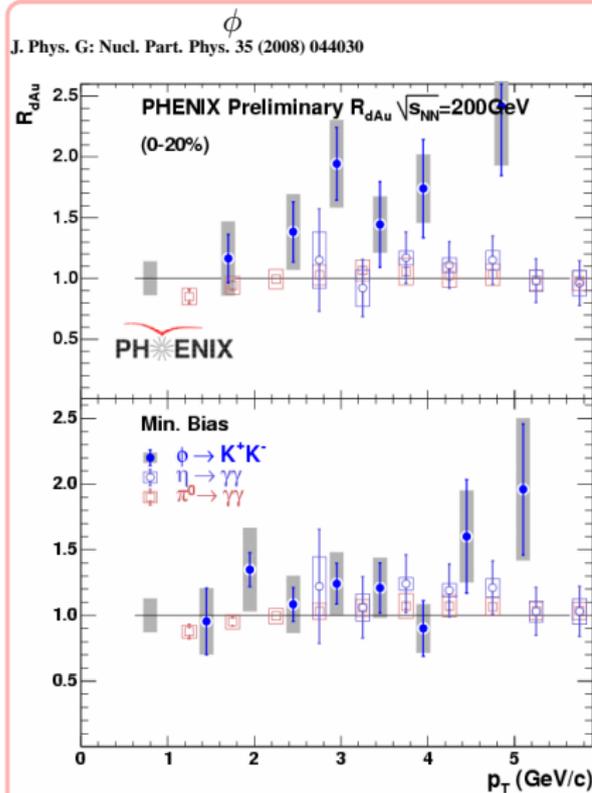


- The different analysis techniques used to measure $\phi \rightarrow K^+K^-$ yield the same results in both systems. The measurements using K^+K^- cover a p_T range up to 7 GeV/c in $p + p$ and 5 GeV/c in $d + Au$.
- There is a reasonable agreement between the spectra for e^+e^- and K^+K^- .

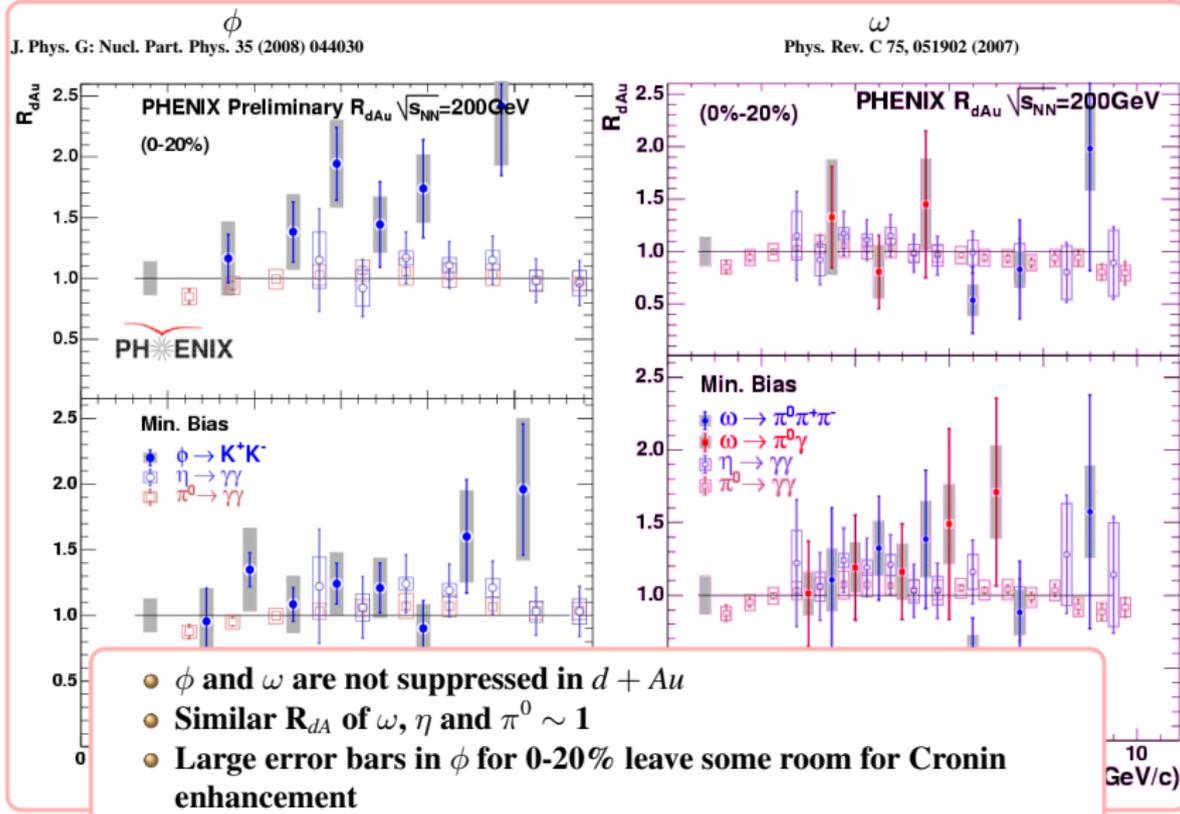


- ω has been measured using several decay channels in both $p + p$ and $d + Au$ (a p_T coverage of 0-12 GeV/c in $p + p$ and 0-9 GeV/c in $d + Au$).
- Good agreement among spectra from various decay channels.

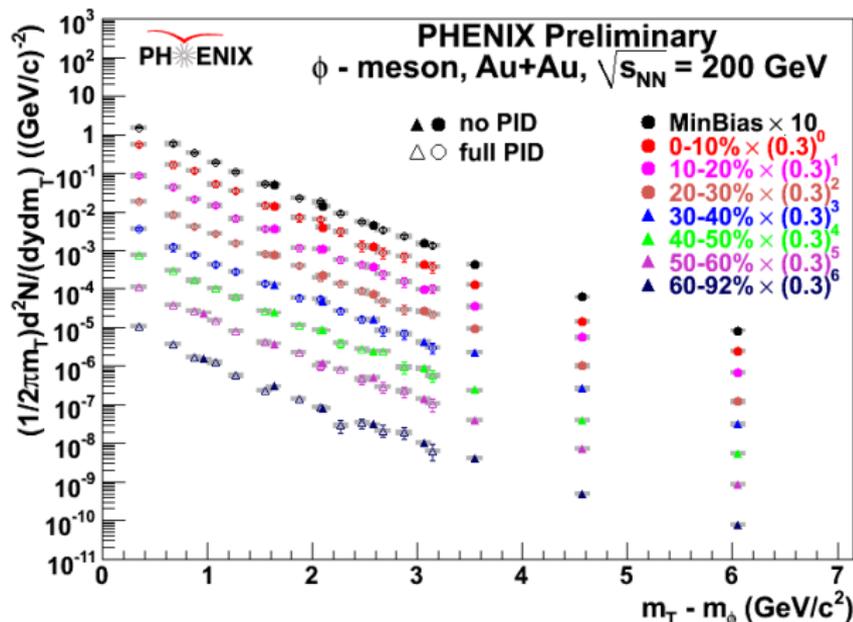
NUCLEAR MODIFICATION FACTORS IN $d + Au$ @ 200 GeV



NUCLEAR MODIFICATION FACTORS IN $d + Au$ @ 200 GeV

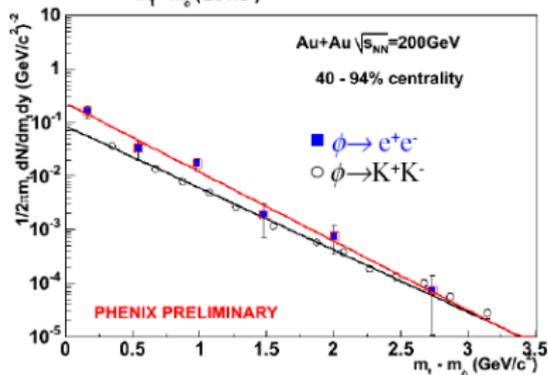
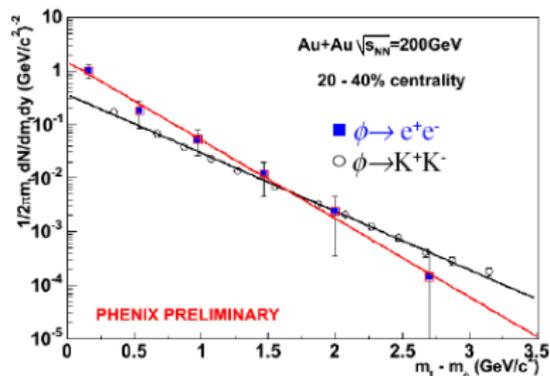
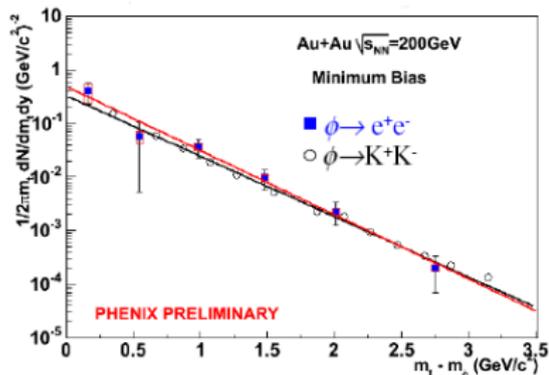


arXiv:0809.3557 [nucl-ex]

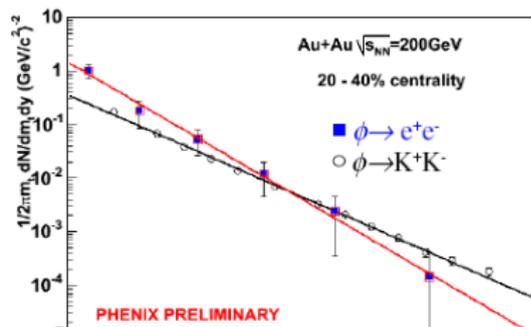
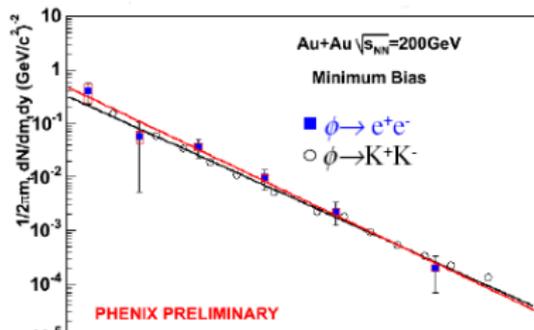


- Two independent analyses in $\phi \rightarrow K^+K^-$ yield same results.
- With no Kaon ID method, Au + Au has been measured up to p_T of 7 GeV/c.

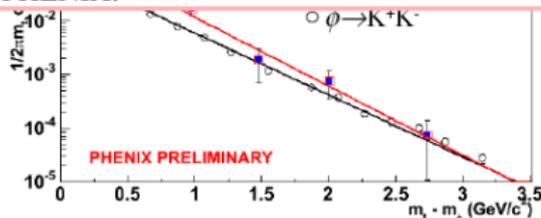
Nucl.Phys. A774 (2006) 739-742

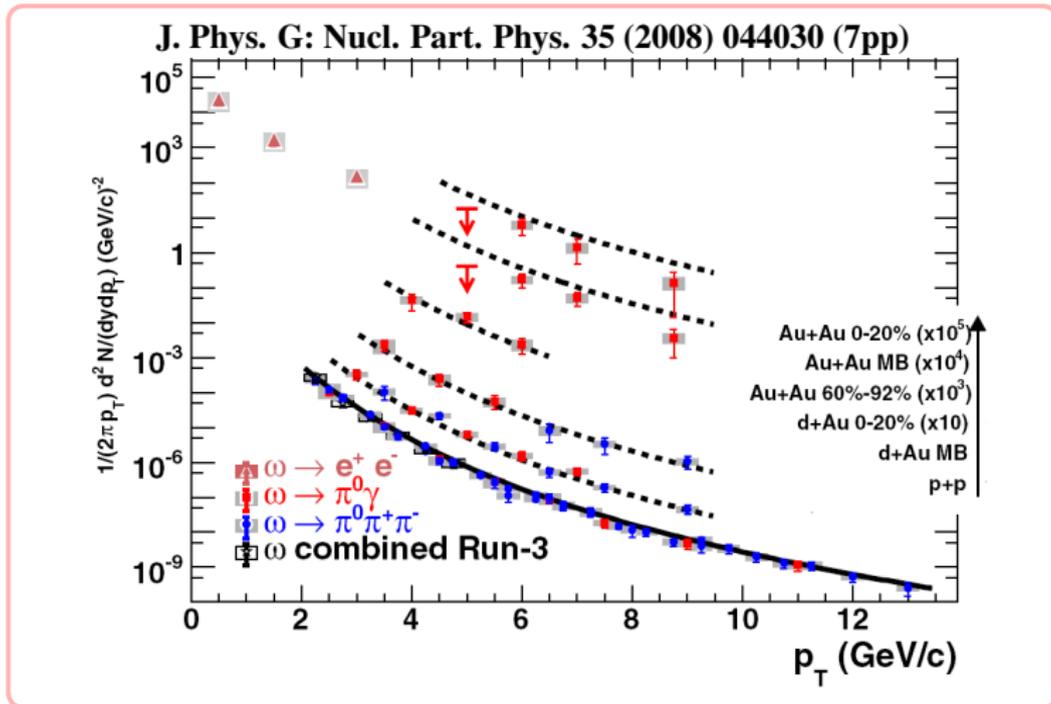


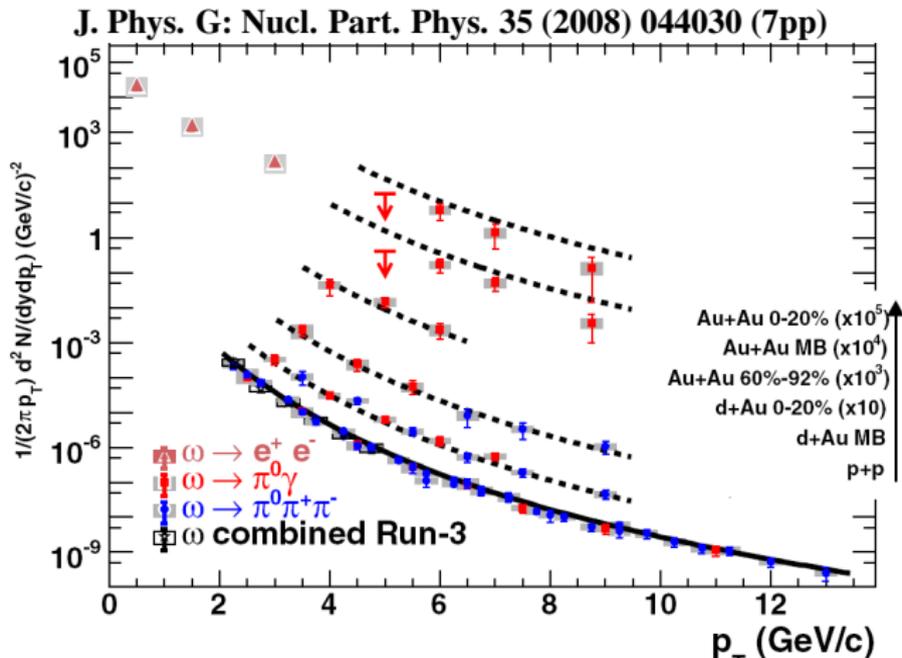
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- The spectra and yields for e^+e^- and K^+K^- can undergo modification inside hot and dense matter formed. The present results for e^+e^- in $Au + Au$ suffer from large uncertainties because of the small S/B ratio and hence do not allow to make a definitive statement.
- The results are expected to improve significantly in the future with the newly built Hadron Blind Detector in PHENIX.





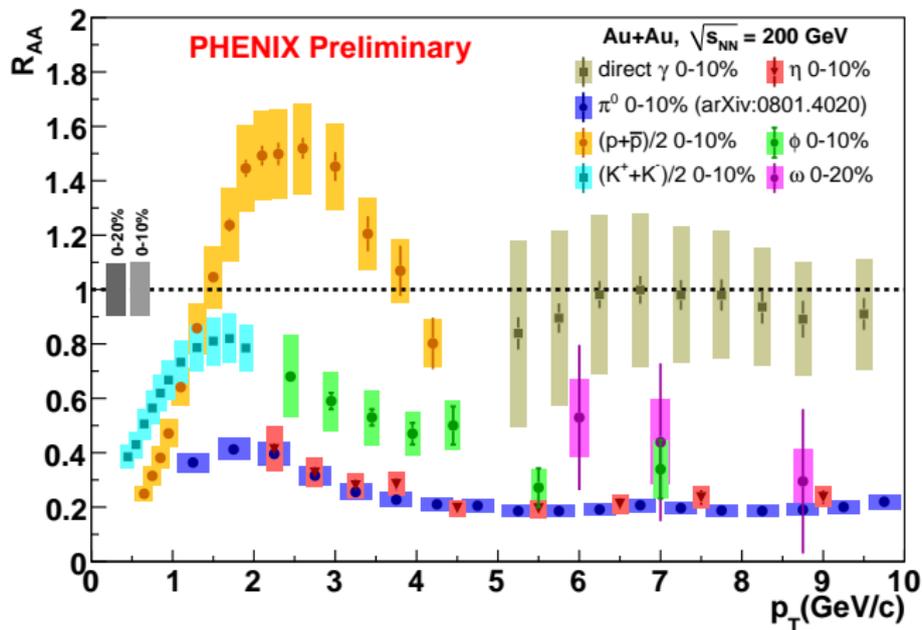


- The solid curve represents a fit to $p + p$ data and the dashed curves are obtained from $p + p$ fits scaled by the corresponding number of binary collisions.

NUCLEAR MODIFICATION FACTOR R_{AA} IN $Au + Au$ 200 GEV

IN CENTRAL COLLISIONS

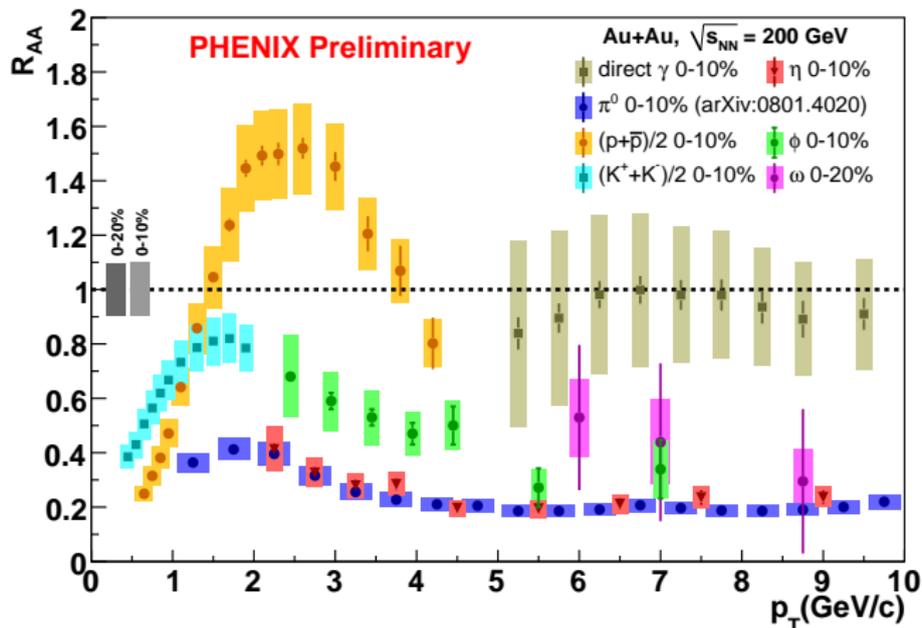
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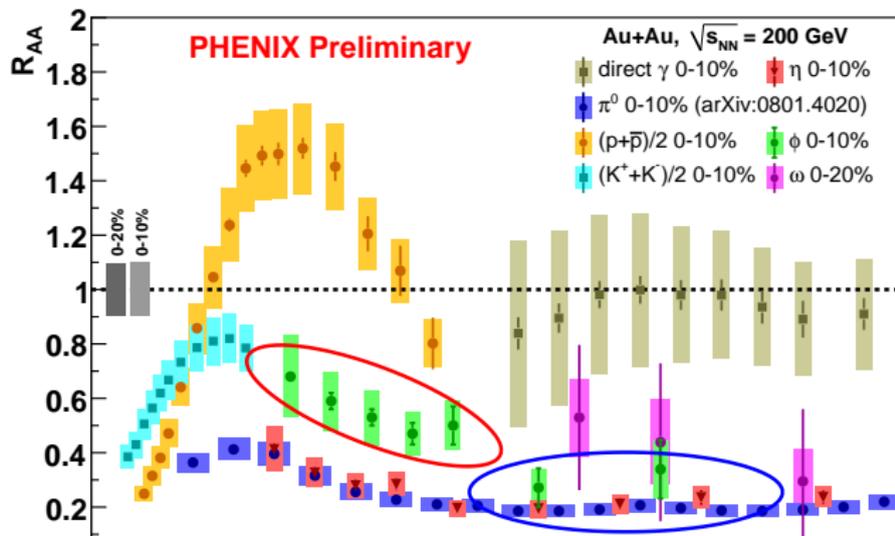


So far we believe that
Hadron suppression patterns do not depend on the mass of the particles, but are sensitive to the number of valence quarks.

NUCLEAR MODIFICATION FACTOR R_{AA} IN $Au + Au$ 200 GEV

IN CENTRAL COLLISIONS

arXiv:0809.3557 [nucl-ex]



ϕ meson does not fit into this picture...

At intermediate p_T : It is more suppressed than protons but less than π^0 and η .

At high p_T : the ϕ -suppression level is similar to that of π^0 and η .

Does suppression depend on quark flavor composition?

The ω points are not conclusive.

More details in the talk by V.Ryabov

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PHENIX has measured ϕ -meson in $p + p$, $d + Au$ and $Au + Au$ collisions @ $\sqrt{s_{NN}} = 200\text{GeV}$ by K^+K^- and e^+e^- decay modes.

The measurements using K^+K^- decay channels are complete in all systems. Different analysis techniques, yield same results in all the systems. Measurements cover wide p_T coverage.

The leptonic channel measurements suffer from the combinatorial background and statistics in $Au + Au$ and $d + Au$. The preliminary results from $p + p$ are shown.

In $d + Au$, no suppression is seen for both ϕ and ω , but large error bars in case of ϕ make room for Cronin enhancement.

The R_{AA} of ω is inconclusive due to large error bars.

The R_{AA} of ϕ -meson in $Au + Au$ shows similar suppression pattern to that of π^0 and η at high p_T , but at intermediate p_T , the suppression pattern is different.

This is not understood, but could be a hint to quark flavour dependence.

$p + p$

Final results of ϕ and ω measurements via e^+e^- in $p + p$ decay channel will be available soon.

$d + Au$

The high statistics run8 $d + Au$ data is available now for analysis and we hope to get better results in e^+e^- channel soon, with this new data set.

$Au + Au$

The current measurements in $Au + Au$ suffer due to small S/B ratio. The newly installed Hadron Blind Detector will improve the quality of measurements by at least one order of magnitude in the near future. *for details refer to talk by Z.Citron.*

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PHENIX

14 Countries; 69 Institutions



July 2007

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PHENIX

14 Countries; 69 Institutions



July 2007

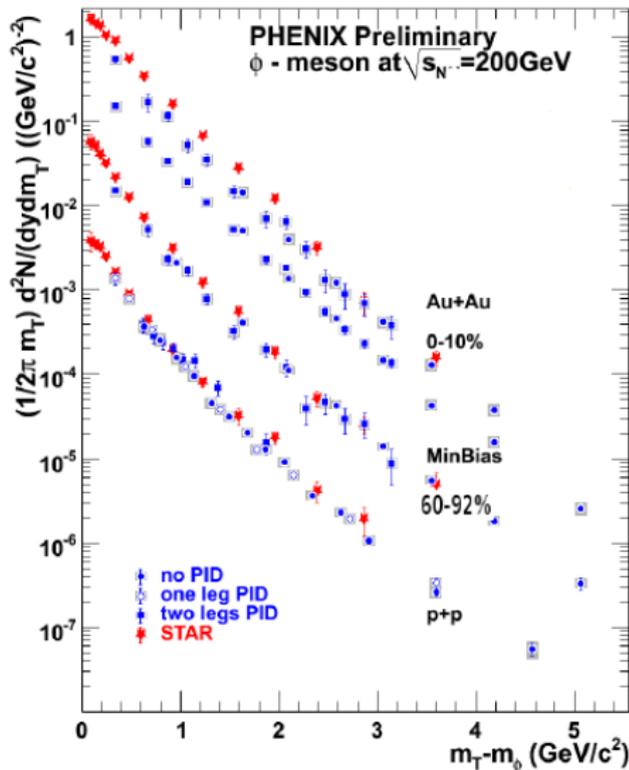
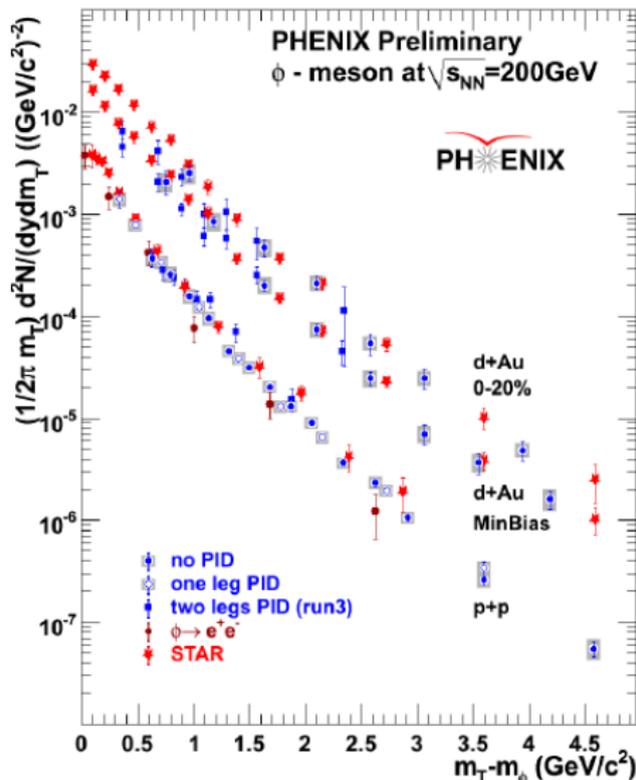
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THANK YOU!

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Back ups

COMPARISON WITH STAR



HADRON BLIND DETECTOR FOR PHENIX

- The measurements in e^+e^- channel suffer due to huge combinatorial background, arising mostly due to uncorrelated pairs from γ - conversions and π^0 Dalitz decays.
 - HBD identifies and vetoes e^+e^- from these sources via opening angle.
- HBD concept
 - Windowless Cherenkov: Radiator Gas = Avalanche Gas, CF_4 ($n \approx 1.000620$), radiator length = 50 cm.
 - Cherenkov light collected as blobs on an image plane.
 - triple GEM stack.
 - ~ 300 nm CsI photocathode on top GEM that used for electron amplification.
 - To preserve the pair opening angle, the magnetic field is turned off (compensated) in the detector.

$B \approx 0$

